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THE RUBBER RESEARCH INSTITUTE OF MALAYA

VOL. 9—AUGUST 1939 COMMUNICATIONS 236 AND 237

EDITORIAL

This is the first issue of the *Journal of the Rubber Research Institute of Malaya* in a new form. Hitherto each Volume has been published in two or three separate Numbers, issued at irregular intervals depending upon how long it took to accumulate in a form suitable for publication, enough individual papers or articles to make up a Number of about the usual size. This procedure had at least two disadvantages: some of the papers or articles were kept unduly long before they were printed; and the results of the Institute's work, being emitted in rather large lumps at longish and irregular intervals, were not so readily assimilated as if they had been issued more often in smaller pieces.

In future, as soon as a paper or article is ready for publication, it will be printed and issued separately, in the usual *Journal* covers, with a reference number. Sometimes two papers on closely related topics, or on successive stages of the same investigation, will be issued together, as in the case of the present issue.

The various communications (papers, articles, reviews etc.) which have been published in the *Journal* since its commencement have been numbered retrospectively, the last paper in Vol. 9 No. 1 being No. 235. The two papers in the present issue are Nos. 236 and 237, and subsequent communications will be numbered serially therefrom.

Volume numbers will be retained, and pagination will be consecutive for each volume. Tables of contents, title pages etc., will be issued on the completion of each volume so that individual volumes may be bound up as hitherto. Vol. 9 will consist of Number 1 issued last July, and the subsequent Journal Communications issued up to the end of 1939.

In the past each paper or article has been referred to briefly in an Editorial at the commencement of the Number, and usually a Summary has also appeared at the end of the paper. In future a Summary, fulfiling both the above functions, will appear *at the beginning* of each paper or article.

J.R.R.I.M. Communication 236

THE SOFTENING OF RUBBER

PART I

THE ADDITION OF SOAPS AND SOFTENERS TO LATEX

BY

V. H. WENTWORTH

Summary

This paper reports preliminary investigations into the softening of rubber by pre-coagulation treatment of latex. Plasticity results are given which show the effect of the addition of emulsions of fatty acids and soaps and indicate the drastic effects of copper, the superiority of zinc soaps as softeners and the use of alkali soaps as emulsifiers in tests of softening agents.

The incorporation of pine tar into latex up to 40 per cent on the dry rubber has been found possible and comparative plasticity data on a number of conventional softeners are reported. The possibility of master-batch preparation of softeners in plantation practice is suggested.

Introduction

Crude raw rubber as received by manufacturers has to be reduced by heating and mechanical working to a soft plastic condition to permit incorporation of the essential compounding ingredients. These operations consume time and power and it is therefore pertinent to enquire whether this consumption could be reduced by modifying the method of preparation of the rubber on the plantation. That there is a demand for a rubber softer than the plantations now supply is shown by the fact that plant is in operation using the Ungar-Schidrowitz process (1, 2, 3, 4, 5), in which rubber is crumbed, washed, dried in vacuo, allowed to oxidise and finally milled into slabs.

In the factory, the preliminary working or mastication is usually followed by the addition of one or more liquid or solid softening agents which promote further softening and ease of processing, the choice being governed by the method of manufacture and nature of the final product. A class of softening agents has lately become available which brings about a pronounced peptisation or disaggregation of the rubber when milled into it, effecting a reduction in power consumption and permitting of modifications to formulae (6, 7, 8). It is sometimes recommended that the rubber, on removal from the mill should be held at an elevated temperature.

The object of the present work is to investigate the possibilities of methods of softening rubber which might be used in estate practice with the minimum of expenditure on additional appliances. Previous work of this nature included a test of a proprietary softening oil which was carried out in 1934 but proved it to be insufficiently effective (9). It was also shown that excessive dilution of latex before coagulation did not appreciably influence the softness of the product (10) nor were the advantages obtained by autoclaving latex sufficient to warrant the expense (11).

A promising line of attack is the treatment of latex prior to coagulation with substances which will bring about softening in the course of the normal smoking and drying process. To form a basis of comparison with these newer types of peptisers it was considered desirable to examine the effects of conventional softeners and allied materials used in this way. This paper covers only that part of the investigation and should be read in conjunction with the paper by Hastings which follows it (Part II).

Experimental

The Addition of Fatty Acids and their Soaps to Latex

In the first place it was decided to obtain data concerning the plasticity of rubber prepared from latex to which the common fatty acids and their soaps had been added prior to coagulation. Apart from their possible use as softeners, some of these substances might be used as emulsifying agents in preparing dispersions of other materials. Blow and Garner (12) examined the effects of fatty acid softeners in dry rubber and used three per cent. of softener on the rubber. This proportion was adopted and used but no adjustments of quantities to compensate for different equivalent weights of the metals in the soaps were made in this work.

The soluble soaps were added to the latex in the form of a solution but the insoluble soaps and fatty acids had to be incorporated in the form of an emulsion. This was prepared by dispersing the soap or acid in benzene and passing the dispersion through a hand emulsifier simultaneously with ammoniacal water. In order to obtain satisfactory emulsions it was necessary to vary the amount of benzene, and also exercise care in the manipulation of the emulsifier, which contributed largely to the success or failure of the operation. Tests had shown that the addition to the latex of emulsified benzene had no effect on the hardness of the resultant rubber. An estimation of the ash in the rubber with and without addition of potassium oleate showed that less than

half the soap remained in the dried rubber but the amounts of soluble soaps added were not increased on this account. The insoluble soaps appeared to be completely absorbed.

The addition of the solutions or emulsions to fresh field latex reduced the dry rubber content to 25 per cent which was further reduced to about 20 per cent by the coagulant. It was found impossible to obtain smooth coagulation with formic acid, immediate clotting taking place on addition of its solutions. It is of interest to note that a patent claiming the acceleration of acid coagulation by addition of a soap has been filed (13). Smooth coagulation was, however, obtained by the use of 0.3 per cent sodium silicofluoride solution. The quantities used were adjusted to produce rapid coagulation and lessen the possibility of poor distribution should any of the emulsions tend to break after addition to the latex. The coagula were passed through a sheeting battery and dried in air at 120°F. for four days.

Plasticity measurements before and after mastication of the samples were made in a Williams plastometer. They are recorded as D_{30} values or the thickness to which a pellet weighing 0.4 grams is compressed in 30 minutes under a weight of 5 kg. at a temperature of 100°C. (14). An economy in time was effected by using a modified procedure whereby the D_{30} value was obtained from a $D_{9\frac{1}{2}}$ reading by the use of corrections given in Table I (15).

TABLE I

$D_{9\frac{1}{2}}$ measured	Amount to subtract to obtain D_{30}
51 — 60	14
61 — 70	15
71 — 80	16
81 — 90	17
91 — 100	18
101 — 110	19
111 — 120	20
121 — 130	21
131 and over	22

It was felt that a test of initial plasticity should be supplemented by a mastication test whereby any additional softening due to the presence of the added material would be indicated. A D_{30} value was therefore determined after passing a 15 grams sample ten times through a cold 12-inch mill of roll diameter 6 inches, differential 1 : 1.4 and a nip of .010 inch. The effect on

TABLE II

Effect on Plasticity of the addition to Latex of 3 per cent. on the dry Rubber, of Soaps and Fatty Acids

	STEARATES				OLEATES				PALMITATES				LINOLEATES			
	Initial D_{30}	After 10 grindings D_{30}	Softening (Initial) Per cent	Softening (after grindings) Per cent	Initial D_{30}	After 10 grindings D_{30}	Softening (Initial) Per cent	Softening (after grindings) Per cent	Initial D_{30}	After 10 grindings D_{30}	Softening (Initial) Per cent	Softening (after grindings) Per cent	Initial D_{30}	After 10 grindings D_{30}	Softening (Initial) Per cent	Softening (after grindings) Per cent
Free Acid ...	1.51	1.19	7.4	9.9	1.48	1.22	9.2	7.6	1.51	1.20	7.4	9.1	1.48	1.17	9.2	11.4
Ammonium ...	1.55	1.23	4.9	6.8	1.47	1.23	9.8	6.8	—	—	—	—	1.47	1.13	9.8	14.4
Sodium ...	1.41	1.21	13.5	8.3	1.46	1.22	10.4	7.6	1.47	1.15	9.8	12.9	—	—	—	—
Potassium ...	1.50	1.25	8.0	5.3	1.56	1.23	4.3	6.8	1.54	1.24	5.5	6.1	—	—	—	—
Copper ...	—	—	—	—	Too soft to test. A sticky semi-liquid.		—	—	—	—	—	—	—	—	—	—
Magnesium ...	1.25	1.04	23.3	21.2	1.47	1.23	9.8	6.8	—	—	—	—	—	—	—	—
Calcium ...	1.48	1.23	9.2	6.8	1.43	1.15	12.3	12.9	—	—	—	—	—	—	—	—
Zinc ...	1.22	0.92	25.1	30.3	1.17	0.96	28.2	27.3	—	—	—	—	—	—	—	—
Barium ...	—	—	—	—	1.54	1.27	5.5	3.8	—	—	—	—	—	—	—	—
Aluminium ...	1.50	1.28	8.0	3.0	1.45	1.10	11.0 Hardens	16.7	1.43	1.23	12.3	6.8	—	—	—	—
Tin ...	—	—	—	—	1.67	1.31	–2.5	0.8	—	—	—	—	—	—	—	—
Lead ...	1.49	1.16	8.6	12.1	1.47	1.19	9.8	9.9	—	—	—	—	—	—	—	—
Iron ...	—	—	—	—	1.21	1.00	25.8	24.2	—	—	—	—	—	—	—	—
Nickel ...	—	—	—	—	1.07	0.94	34.4	28.8	—	—	—	—	—	—	—	—
Trihydroxy-triethylamine ...	—	—	—	—	—	—	—	—	—	—	—	—	1.54	1.28	5.5	3.0

Plasticity of control rubber D_{30} *1.63*
Plasticity of control rubber after 10 grindings, D_{30} *1.32*

crude rubber was a softening of approximately 20 per cent, as shown in Table IV, but this varied considerably between different samples of rubber and consequently a control test was always necessary.

In Table II the plasticity results are recorded for four fatty acids and 26 of their soaps, together with the percentage softening, initially and after the mastication test. The calculations are based on the plasticity of the control rubber before and after mastication, softening being calculated as a percentage change in D_{30}.

From the results shown it appears that the free acids do not exert pronounced softening effects which for practical purposes are identical, while the soaps generally are more effective than the acids.

Of the three soluble alkali soaps sodium soaps appear to be slightly better but the quantities required to stabilise emulsions of other substances would have little effect on the plasticity of the resultant rubber.

Apart from copper oleate, which would not be considered as a compounding ingredient in normal manufacture, the lowest initial plasticity is associated with nickel oleate. After mastication, however, it is little better than zinc oleate and inferior to zinc stearate. Nickel would probably be regarded as one of the dangerous metals to associate with rubber in view of the known effects of cobalt to which Stevens has drawn attention (16,17).

The hardening produced by tin oleate has been confirmed, the metal evidently displaying some of the affinity which is used in the process of cyclisation produced under other conditions (18).

The zinc soaps of stearic and oleic acids have most to recommend them as softeners. Although initially they do not soften rubber to the same extent as nickel oleate, their effectiveness is much enhanced by the subsequent mastication. They are materials of proved safety in rubber compounding and not subject to the doubts associated with a metal such as nickel, apart from the question of cost.

The Effects of the Addition of Pine Tar

Pine tar is one of the most effective softeners in common use and it was of interest to examine its effect when incorporated into rubber by addition to latex. Amounts of from one to 40 per cent on the dry rubber were added.

A number of emulsions were prepared by first warming the pine tar in water containing potassium oleate. At 70°C. the pine tar broke up on stirring into small globules and formed a partial emulsion. This was then passed through a hand emulsifier three

times together with a further quantity of water, such that the final volumes of the emulsions of different concentrations were all the same. These emulsions were added to fresh field latex and the mixtures, which then had D.R.Cs. of approximately 12 per cent, were coagulated overnight with a 0.5 per cent solution of sodium silicofluoride. The coagula were passed through a sheeting battery and dried in air at 120°F. for four days.

TABLE III

Plasticity of Rubber from Latex containing Pine Tar

Concentration of Pine Tar on dry rubber Per cent.	Initial D_{30} (III A in Fig. 1)	After 10 grindings D_{30} (III B in Fig. 1)	Softening (Initial) Per cent.	Softening (after grinding) Per cent.
0	1.57	1.28	—	—
1	1.56	1.25	0.6	2.3
2	1.57	1.22	0.0	4.7
3	1.50	1.19	4.5	7.0
4	1.46	1.18	7.0	7.8
5	1.41	1.14	10.2	10.9
10	1.26	0.97	19.7	24.2
20	0.98	0.80	37.6	37.5
30	0.81	0.62	48.4	51.6
40	0.67	0.54	57.3	57.8

TABLE IV

Mastication of Crude Rubber from Latex used in Preparation of Samples in Table III

Number of mill grindings @ .010 inch	D_{30} (IV in Fig. 1)	Softening Per cent.
0	1.57	—
5	1.41	10.2
10	1.25	20.4
15	1.15	26.8
20	1.08	31.2
30	0.89	43.3
50	0.64	59.2
70	0.49	68.8
100	0.38	75.8

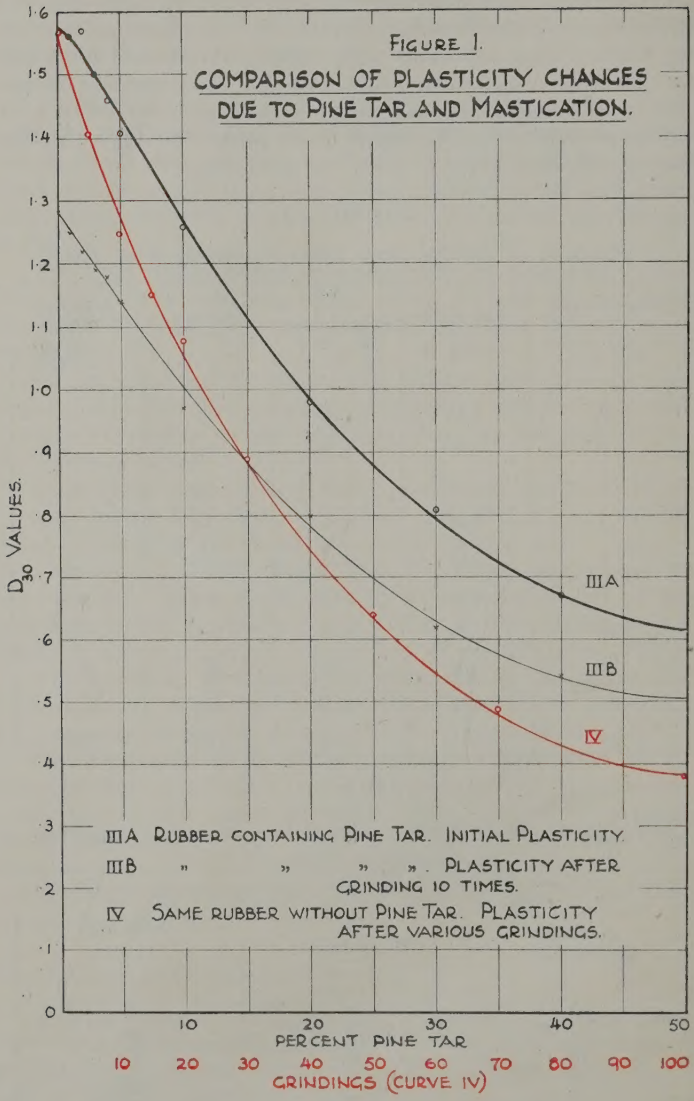
FIGURE 1.
COMPARISON OF PLASTICITY CHANGES DUE TO PINE TAR AND MASTICATION.
D_{30} VALUES.
1·6
1·5
1·4
1·3
1·2
1·1
1·0
·9
·8
·7
·6
·5
·4
·3
·2
·1
0
III A
III B
IV
III A RUBBER CONTAINING PINE TAR. INITIAL PLASTICITY.
III B " " " " . PLASTICITY AFTER GRINDING 10 TIMES.
IV SAME RUBBER WITHOUT PINE TAR. PLASTICITY AFTER VARIOUS GRINDINGS.
10
20
30
40
50
PERCENT PINE TAR
10 20 30 40 50 60 70 80 90 100
GRINDINGS (CURVE IV)

The effect on plasticity is shown in Table III, while Table IV shows the relative effects of various amounts of mill grinding on rubber prepared from the same latex. The results are plotted in Figure 1.

In Figure 1, curve IIIA gives the initial D_{30} values of samples containing different amounts of pine tar whilst IIIB gives their plasticities after the standard mastication. Curve IV shows the effect on plasticity of different amounts of mastication of crude rubber from the same latex. It will be observed that relatively large proportions of pine tar produce a comparatively small degree of softening.

The plasticity which different manufacturers consider desirable varies considerably but D_{30} values of 0.8 and 0.7 are representative of some requirements. The different treatments which will produce these plasticities from crude rubber of D_{30} 1.57 can be obtained from the curves and are as follows:—

Rubber of D_{30} 0.7 is obtained by:—

(a) Inclusion of 37 per cent Pine Tar.

(b) „ „ 25 „ „ „ „ followed by 10 mill grindings at .010 inch.

(c) 44 mill grindings at .010 inch.

Rubber of D_{30} 0.8 is obtained by:—

(a) Inclusion of 30 per cent Pine Tar.

(b) „ „ 19 „ „ „ „ followed by 10 mill grindings at .010 inch.

(c) 44 mill grindings at .010 inch.

Rubber containing the higher proportions of tar was surprisingly firm. That containing 40 per cent showed only a small tendency to plastic flow but the sample containing 30 per cent did not exhibit this tendency and its appearance did not suggest that the rubber was diluted with such a high proportion of liquid. The incorporation of one and two per cent of pine tar gave products which, although air-dried, had the appearance of medium and over-smoked sheet.

A Possible Commercial Application

A general market for rubber containing pine tar or any other compounding ingredient is not at present visualised. But since the incorporation of large amounts of pine tar into rubber seems practicable, the suggestion is made that master-batch preparation on estates might be worthy of consideration by rubber manu-

facturers. After the addition of emulsified pine tar complying with the manufacturer's specification, latex could be treated by modifications of present estate methods.

Modern large-scale production of pine tar and stearic acid master-batches involves disintegrating the rubber, dipping in the heated softener and batching on an apron-mill. By using the suggested process, cost reduction of equipment and processing appears possible, at the same time eliminating from the rubber works an undesirable series of operations, whilst also offering the advantages of master-batch compounding.

There are obvious difficulties militating against such a scheme but it is put forward in the belief that it is novel and may suggest possibilities making it worthy of closer consideration by the manufacturers concerned.

The Effects of other Softeners

In order to obtain more data upon the softening obtainable with conventional softeners, seven others, of which two were proprietory, were tested in comparison with pine tar. For this purpose one concentration of softener was sufficient and 10 per cent was selected. The results are shown in Table V.

TABLE V

Effect on Plasticity of the addition of various Softeners at a concentration of 10 per cent. on the Rubber

Description	Initial D_{80}	After 10 grindings D_{80}	Softening (Initial) Per cent.	Softening (After grinding) Per cent.
Rubber without softener ...	1.62	1.32	—	—
Pine Tar ...	1.30	1.02	19.8	22.7
Tackol ...	1.30	1.03	19.8	22.0
Rubberine Gel ...	1.25	1.00	22.8	24.2
Rosin Oil ...	1.28	1.00	21.0	24.2
Stearic Acid ...	1.24	1.01	23.4	23.5
Lanolin ...	1.18	1.00	27.2	24.2
Petroleum Jelly ...	1.26	1.02	22.2	22.7
Coal Tar ...	1.35	1.05	16.7	20.5

No outstanding effects are indicated in the table. This was not unexpected, as the conventional types of softeners are more in the nature of diluents and lubricants rather than chemicals which bring about alterations in structure. The indications are that the previous remarks on the subject of master-batches prepared from latex are applicable to other materials used in quantity, in particular stearic acid.

Acknowledgment

Thanks are due to the Singapore Rubber Works Ltd. for supplying the rubber grade chemicals used in this work. The practical assistance given by Lek Kay Tee and A. G. Lee is gratefully acknowledged.

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Kuala Lumpur

21st April, 1939

THE SOFTENING OF RUBBER

PART II

THE PREPARATION OF SOFT RUBBER BY PRECOAGULATION TREATMENT OF LATEX*

BY

J. D. HASTINGS

Summary

Experiments are described on the incorporation of emulsions of "peptising agents" into latex prior to coagulation, and the subsequent softening of the dry rubber induced by the drying treatment to which the wet sheet is subjected.

It is shown that the temperature used in this drying treatment affects the softness of the dry rubber, and that high temperatures in the early stages of drying appear to assist the softening markedly.

The preparation of soft rubber by the means suggested is worthy of further consideration by both producers and consumers.

Introduction

The Chemical Division Annual Report for 1937 (1) contains the following paragraph concerning investigations then in progress on the preparation of modified rubbers:—

"PREPARATION OF SOFT COMMERCIAL RUBBERS

During the year experiments have been made on the incorporation of "peptising agents" into latex with a view to obtaining a soft rubber as a result of the effect of the heat applied during smoking. In the early trials phenylhydrazine hydrochloride solution was applied to latex shortly before the acid and the resulting rubber was machined and dried in the ordinary way. The rubbers obtained were encouragingly soft and this finding was amply confirmed by our London colleagues to whom samples were sent. Phenylhydrazine hydrochloride is however a toxic substance and although the results obtained with it were encouraging its use could not be recommended to estates because of the health hazard. By the courtesy of E. I. Du Pont de Nemours & Co. of America a small supply of a non-toxic "peptising agent" was obtained. The material is however insoluble in water though soluble in acetone, which itself is a coagulant for latex. These facts introduced the problem of uniform incorporation into latex. In early trials the incorporation lacked

*The processes described in this paper are the subject of a British Patent application.

uniformity and the sheets of rubber obtained were unsatisfactory because they had hard and soft places on their surfaces. The degree of softening was however such as to encourage further efforts to achieve uniform incorporation and a general as distinct from localised softening. Towards the end of the year means were found for obtaining a perfectly uniform dispersion of the material throughout the body of the latex. Uniformly soft rubbers resulted, which have encouraged the view that the process has commercial possibilities. With the arrival of further supplies of the "peptising agent" the work will be pressed forward and trial batches will be prepared for manufacturers' tests. Unlike other processes for the preparation of soft rubber it would not involve estates in the installation of large and expensive plant; one small machine only would be required costing in the neighbourhood of £40 and existing estate equipment would be employed for all other operations."

This paper amplifies that paragraph, gives an account of the work carried out since then and records the present position.

Experimental

Materials used

The rubber "peptising agents" with which the experiments have been made are those known as R.P.A. No. 1, R.P.A. No. 2, R.P.A. No. 3 and thio-beta-naphthol. These are chemicals which have been successfully introduced to the rubber industry within the last two years by their makers Messrs. E.I. Du Pont de Nemours (2) to assist the breakdown of raw rubber on the mill, shorten the milling time and enhance the softening during mastication.

R.P.A. No. 1 is the zinc chloride double salt of phenylhydrazine. In order to obtain the maximum plasticising effect from its addition on the mill it is necessary to store the masticated rubber at an elevated temperature. The temperature and period of storage depend on the degree of softness required and the amount of peptising agent added. Considerable care is required in the handling of R.P.A. No. 1 owing to its toxic nature.

Further research work enabled Messrs Du Pont to produce and market the improved "peptiser" known as R.P.A. No. 2. This material consists of a mixture of one-third naphthyl-beta-mercaptan and two-thirds inert hydrocarbon. It functions only during milling, and storage at high temperature after mastication is not required, as subsequent heat treatment has no further effect. The efficiency of the "peptiser" is increased however as the milling temperature is raised, and hot mastication is therefore advisable. Although the makers believe R.P.A. No. 2 to be non-toxic they advise care in handling.

Recently R.P.A. No. 3 has been produced and is now sold at a much reduced price. It is a yellow liquid which consists of a mixture of one-third xylyl-mercaptan and two-thirds inert hydrocarbon. It functions in the same manner as R.P.A. No. 2 and is said to be equally effective in the same amounts. As with R.P.A. No. 2 care in handling is advised although it is believed that it is less likely to cause skin trouble than either of the other peptising agents.

Experiments with R.P.A. No. 1

The earlier work which aimed at the incorporation of R.P.A. No. 1 into the latex before the addition of the coagulant was not promising because of the uneven distribution of the "peptising agent." Although these difficulties were overcome it is unlikely that R.P.A. No. 1 could be used with safety in plantation practice on account of health hazards. Details of these experiments are omitted therefore, because the introduction of R.P.A. No. 2 and R.P.A. No. 3 has since made it unnecessary to give further consideration to the possibility of using R.P.A. No. 1 to prepare soft rubber on the plantations.

Experiments with Thio-beta-naphthol

Thio-beta-naphthol, or naphthyl-beta-mercaptan, is the chemical constituent of R.P.A. No. 2 which is responsible for the "peptising" action. Experiments were carried out to obtain information concerning the effect of the active agent alone, on sheet rubber prepared from latex to which it had been added prior to coagulation.

Owing to the insolubility of thio-beta-naphthol in water it cannot be uniformly incorporated into latex unless it is first dispersed in a liquid which is compatible with latex. A volatile solvent has the advantage of being easily removed after coagulation has occurred, but owing to rapid evaporation there is a tendency for some of the solid material to be deposited. Moreover, all the common solvents in which thio-beta-naphthol is soluble are themselves coagulants of latex, and the addition of such a solution to latex causes local clotting and consequent uneven distribution.

Preparation of Emulsions

Experiments were therefore made to ascertain if the "peptising agent" could be dissolved in an organic solvent and the solution subsequently emulsified in water. By the addition of such an emulsion to the latex it was hoped that uniform distribution of the thio-beta-naphthol would be obtained, particularly if it was

added shortly before the coagulant, because the resulting flocculation and coalescence following the addition would help to maintain even distribution when the emulsion broke. Satisfactory emulsions were prepared by emulsifying benzene solutions of thio-beta-naphthol in water using potassium oleate as a stabiliser. At first a colloid mill was not available and the emulsions were prepared with the aid of a laboratory hand emulsifier. When larger quantities were required a Premier paste mill was used with the gap set at 0.003 inch. Although of slow speed this mill gave emulsions which were sufficiently stable to permit easy and uniform incorporation into latex without local clotting, but they could not be kept for longer than 24 hours owing to their tendency to cream. The creaming was not pronounced in the early hours of storage and the cream was readily dispersed on shaking, but as the period of storage increased creaming became more definite and the rapidity of separation was greater after re-dispersion. Freshly prepared emulsions were therefore always used in the work. Experiments were made which showed that the addition to latex of emulsions in water containing similar amounts of benzene and stabiliser but no peptising agent had only a very slight effect on the resulting rubber.

Incorporation into Latex

Table 1 gives figures showing the plasticity changes which occur in smoked sheet rubber prepared from latex to which increasing amounts of an emulsion of thio-beta-naphthol were added before coagulation. The emulsion was made by dissolving 10 grammes of thio-beta-naphthol in 100 c.c. of benzene, adding this to 900 c.c. of water containing two grammes of potassium oleate and passing the mixture three times through a Premier paste mill with gap set at 0.003 inch.

The addition of the emulsion did not effect the coagulation of the latex in any way and no extra coagulant was required, the amount used being that normally needed for overnight coagulation. No difficulty was experienced in sheeting the coagulum which was quite normal. The wet sheet was drained for four hours and then dried in an estate smoke-house maintained at a temperature of 125°—135°F. Drying was normal and apart from the soft and short feel of the sheets and a surface tackiness in those containing the higher amounts of "peptiser," no other differences were observed. The stickiness of the sheets containing most thio-beta-naphthol was insufficient to cause trouble in estate practice, although considerable care would be required to prevent sheets from massing in the interval between removal from the smoke-house and packing.

Plasticity Measurements

The plasticity measurements were made with the Mooney shearing disc plastometer (3) and both plasticity and a mastication test were usually carried out. The mastication test is a measure of the number of grindings required by a sample of 50 gramme weight to give a Mooney value of 50, using a laboratory mixing mill with water-cooled 12 x 6 inch diameter rolls of speeds 25 and 35 r.p.m. and nip of 0.040 inch (4). It is reported as the M 50 value.

TABLE I

Plasticity of Smoked Sheet prepared from Latex containing Thio-beta-naphthol Emulsions

Dry-Rubber-Content of Latex = 15 per cent. Drying Temperature 125°—135° F.

Sample No.	Time of drying	Emulsion added on Volume of Latex	Thio-Beta-Naphthol added on Rubber	Plasticity	
				Mooney Value	M 50 Value
	hours	per cent.	per cent.		
L 51	101	—	—	71	53
L 51/1	101	1.1	0.076	74	33
L 51/2	117	2.2	0.152	66	22
L 51/3	117	3.3	0.228	56	13
L 51/4	117	4.4	0.304	54	8

From the M 50 values above it is evident that progressive softening occurs as the amount of "peptising agent" added to latex is increased. A peculiar feature of the Mooney values is the apparent hardening caused by the addition of 0.076 per cent of thio-beta-naphthol, the value rising from 71 to 74. The sample however requires less mastication as indicated by an M 50 value of 33 compared with 53 for the control. This apparent hardening is also noticed in the early stages of masticating ordinary crude rubber when the amount of milling is very small, and confirms the observations of Hoekstra (5) who noted the same phenomenon when using a new type of apparatus for the rapid determination

of plasticity. He ascribes the effect to stresses set up in the rubber by the first few passes through the rolls and compares it to strain hardening in metals. Whilst this may be the explanation in the case of slight mastication it is difficult to understand why the initial plasticity of a material containing a small amount of a known rubber softener should show apparent hardening.

Vulcanising and Ageing Properties

The use of R.P.A. No. 2 as a "peptiser" on the mill has no adverse affect on the vulcanising or ageing properties of the rubber to which it is added (6). In order to ascertain if this is also true when its active constituent thio-beta-naphthol is added to the latex prior to coagulation, the smoked sheet prepared in the above experiments was vulcanised in rubber-sulphur and "Captax" mixes, and oxygen bomb ageing tests were carried out on diphenyl-guanidine accelerated mixes.

Cured in rubber-sulphur (100 : 10) mixes at 148°C. for 120 minutes the moduli at 700 per cent elongation were as follows:—

L 51	...	...	...	0.35 kg/sq.mm.
L 51/1	...	...	...	0.34 „
L 51/2	...	...	...	0.38 „
L 51/3	...	...	...	0.44 „
L 51/4	...	...	...	0.45 „

The addition of the thio-beta-naphthol appears to have accelerated the cure slightly, the largest difference in modulus between the samples representing an approximate period of 10 minutes to reach the maximum tensile strength, or an acceleration of approximately seven per cent in time of vulcanisation.

Table II gives the results of vulcanising the samples in the "Captax" recipe for raw rubber of the American Chemical Society's Crude Rubber Committee.

These figures do not indicate that the use of thio-beta-naphthol has accelerated the curing rate as was expected (6), and it is apparent that it has not affected the vulcanisation properties to any great extent, although it would appear that those samples containing the larger amounts of "peptiser" have slightly lower tensile strengths. Ageing experiments were also made on rings cut from vulcanisates cured in diphenyl-guanidine accelerated mixes and the results are shown in Table III.

TABLE II

Vulcanisation in "Captax" mixes at 127°C.

Rubber	*100*
Zinc Oxide	*6*
Sulphur	*3.5*
Stearic Acid	*0.5*
Mercapto-Benzothiazole	*0.5*

Sample No.	Modulus at 700 per cent. Elongation kg/sq.mm.						Tensile Strength kg/sq.mm.						Percentage Elongation at break					
	Time of cure in mins.						Time of cure in mins.						Time of cure in mins.					
	20	30	40	50	60	80	20	30	40	50	60	80	20	30	40	50	60	80
L 51 ...	0.14	0.25	0.35	0.41	0.45	0.50	0.63	1.09	1.32	1.52	1.56	1.56	1050	1013	973	964	949	923
L 51/1 ...	0.12	0.23	0.33	0.40	0.45	0.50	0.59	1.07	1.35	1.37	1.38	1.48	1064	1023	985	942	918	909
L 51/2 ...	0.15	0.25	0.34	0.41	0.45	0.51	0.73	1.04	1.35	1.37	1.41	1.55	1070	1004	968	939	929	921
L 51/3 ...	0.14	0.25	0.32	0.40	0.44	0.50	0.71	1.07	1.23	1.38	1.43	1.44	1066	1009	949	952	933	908
L 51/4 ...	0.13	0.23	0.31	0.39	0.43	0.50	0.64	1.00	1.21	1.36	1.38	1.39	1060	1017	969	958	910	902

TABLE III

Effect of Thio-beta-Naphthol on Ageing Properties of Smoked Sheet cured in "D.P.G." Mixes at 141°C.

Rubber	*100*
Zinc Oxide	*5*
Sulphur	*4*
Diphenyl-Guanidine	*0.75*

Vulcanised Rings aged in Oxygen at 60°C. and 300 lb/sq. inch. Pressure

Experiment No.	Amount of Thio-Beta-Naphthol added on Rubber	No. of hours aged	Modulus at 700% Elongation kg/sq.mm.				Tensile Strength kg/sq.mm.				Percentage Loss in Tensile Strength				Mean Percentage Loss
			Time of cure mins.				Time of cure mins.				Time of cure mins.				
	Per cent.		40	60	80	100	40	60	80	100	40	60	80	100	
L 51	—	0	0.74	1.03	1.19	1.26	1.52	1.72	1.68	1.67					
		96					1.24	1.13	0.83	0.22	18	34	54	87	48
L 51/1	0.076	0	0.66	0.97	1.17	1.26	1.38	1.57	1.59	1.60					
		96					1.11	1.02	0.88	0.20	20	35	45	87	47
L 51/2	0.152	0	0.62	0.94	1.18	1.31	1.37	1.53	1.58	1.57					
		96					0.95	0.90	0.78	0.29	31	41	50	52	51
L 51/3	0.228	0	0.60	0.94	1.17	1.32	1.32	1.57	1.58	1.56					
		96					0.85	0.88	0.58	0.20	36	44	63	87	58
L 51/4	0.304	0	0.58	0.92	1.15	1.30	1.30	1.53	1.55	1.58					
		96					0.79	0.55	0.21	0.18	39	64	87	89	70

The data in Table III show that the addition of thio-beta-naphthol to latex has a slight adverse effect on the resistance to ageing of the resultant rubber when vulcanised in a diphenyl-guanidine mix. In mixes containing small amounts of thio-beta-naphthol the increases in the mean percentage loss of tensile strength were small, and as it is unlikely that amounts larger than 0.25 per cent on the dry rubber will be used in practice, the changes produced in the ageing properties may be considered to be relatively unimportant. "Captax" mixes aged for a similar period showed an increase in tensile strength in all cases, but since ageing was not carried through to complete deterioration the results are not given here.

Experiments with R.P.A. No. 2

Although R.P.A. No. 2 consists of one-third thio-beta-naphthol and two-thirds inert hydrocarbon, it was understood from Messrs. Du Pont that it can be marketed at less than one-third the price of pure thio-beta-naphthol. It was therefore considered desirable to continue the work with R.P.A. No. 2 as it is known to be commercially available.

TABLE IV

Plasticity of Smoked Sheet prepared from Latex containing R.P.A. No. 2 Emulsions

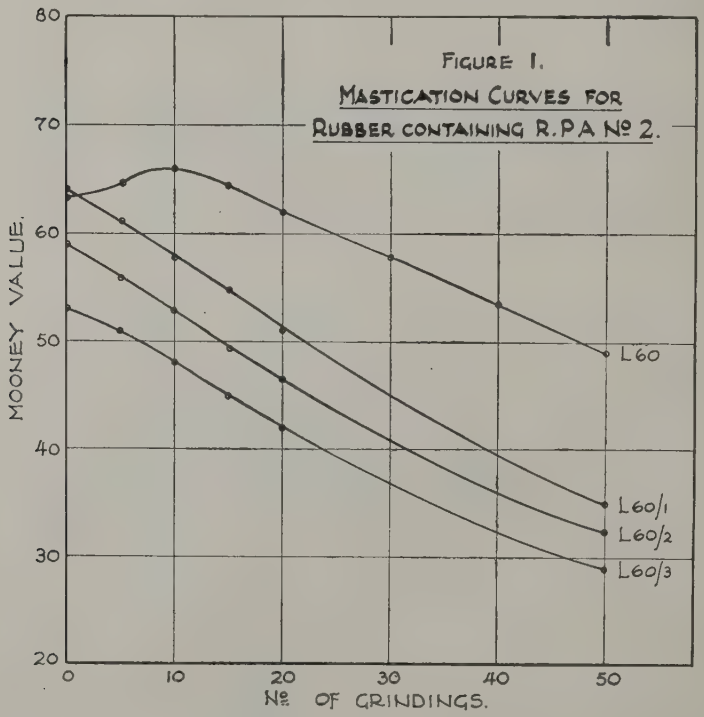
Dry-Rubber-Content of Latex = 15 per cent. Drying Temperature 125—135° F.

Sample No.	Time of drying hours	Per cent. Emulsion added on Latex	Per cent. R.P.A.No. 2 added on dry rubber	Plasticity	
				Mooney Value	M 50 Value
L 60 ...	100	—	—	63.5	47
L 60/1 ...	69	5	0.35	64	22
L 60/2 ...	76	7½	0.52	59	14
L 60/3 ...	69	10	0.69	53	7

An emulsion was made by dissolving 10 grammes of R.P.A. No. 2 in 100 c.c. of benzene and emulsifying this solution in 900 c.c. of water containing two grammes of potassium oleate by passing

through a Hurrell homogeniser with gap set at 0.006 inch. The coagulum was sheeted and the wet sheets dried in the smoke-house. As before, no excessive stickiness in the dry sheets was observed. Figures given in Table IV show the effect of this "peptiser" on the plasticity of smoked sheet made from latex to which various amounts had been added in an emulsified form. The plasticity measurements were carried out shortly after the preparation of the samples.

The softening effect caused by the addition of the R.P.A. No. 2 is very pronounced and is more readily seen in Figure 1 in which the mastication results shown in Table IV are plotted.



The addition of the smallest amount of R.P.A. No. 2 does not appear to have affected the Mooney value, but it is evident from the mastication test that the rubber is more easily softened. The apparent hardening in the early stages of mastication of sample L 60, to which no "peptiser" has been added, is of interest in connection with what has already been mentioned.

The Effect of the Temperature of Drying on Plasticity.

It is recommended that when R.P.A. No. 2 is added to raw rubber on the mill high temperature mastication should be used to ensure maximum softening (6). It was therefore desirable to ascertain if the softening effect of the "peptiser" when incorporated into the latex was dependent on the temperature at which the wet sheet was dried. It was anticipated that the higher drying temperatures would give softer rubbers and this was found to be correct.

TABLE V

Effect of Drying Temperature on Plasticity of Air-Dried Sheet Containing R.P.A. No. 2

Dry-Rubber-Content of Latex = 15 per cent.

Sample No.	Drying Temperature °F	Time of drying hours	Per cent. Emulsion added on Latex	Per cent. R.P.A. No. 2 added on rubber	Mooney value
L 70/1	120	116	—	—	73
L 70/2	„	93	2.5	0.18	82
L 70/3	„	93	5.0	0.36	73
L 70/4	„	93	7.5	0.53	65
L 70/5	„	93	10.0	0.71	59
L 70/6	„	93	12.5	0.88	54½
L 70/7	„	93	15.0	1.06	50
L 70/1/1	140	68	—	—	74
L 70/2/1	„	44	2.5	0.18	69½
L 70/3/1	„	44	5.0	0.36	60
L 70/4/1	„	44	7.5	0.53	52½
L 70/5/1	„	44	10.0	0.71	47
L 70/6/1	„	44	12.5	0.88	43
L 70/7/1	„	44	15.0	1.06	37½

Varying amounts of R.P.A. No. 2 emulsions prepared as previously described were added to field latex diluted to 1½ lb. per

gallon which was then coagulated with formic acid overnight. After rolling next morning the wet sheets were dried at 120° and 140°F. in hot-air constant-temperature drying chambers at the Rubber Research Institute. The plasticity results determined shortly after the rubber was prepared are shown in Table V.

The Mooney values indicate that the plasticity varies with the temperature of drying and that a much softer rubber is obtained by drying at the higher temperature. It will also be shown later in this paper, from determinations made on these rubbers after storage, that the plasticity changes due to differences in temperatures of drying increase as the amount of R.P.A. No. 2 used in the preparation increases.

It was also considered likely that a prolonged drying treatment might result in a progressive softening and the results of experiments made to investigate this possibility are given in Table VI. Plasticity measurements are given on sheet subjected to periods of heat treatment in excess of those required for complete drying, and it would appear that this heating has little additional effect on the plasticity of the dry rubber.

TABLE VI

Effect of Prolonged Drying on Plasticity of Smoked Sheet Containing R.P.A. No. 2

Dry-Rubber-Content of Latex = 15 per cent. Drying Time common to all Sheet 116 hours

Sample No.	D.R.C. of Latex	R.P.A. No. 2 added on Rubber	Extra drying time in smoke-house at 125—135°F.	Total drying time	Plasticity	
					Mooney value	M 50 value
	per cent.	per cent.	hours	hours		
L 69/1	15	—	—	116	67	58
L 69/2	„	0.32	48	164	70	29
L 69/3	„	0.32	96	212	71½	29
L 69/4	„	0.32	144	260	70	28
L 69/5	„	0.32	192	308	72½	26

The results are surprising, but they confirm some preliminary observations which had suggested that the temperature during the *early* stages of drying, rather than the total time, had the greatest influence on the plasticity of the dry sheet. Experiments were therefore carried out to obtain further information on these points. A series of wet sheets all containing equal amounts of R.P.A. No. 2 was partially dried in hot air at a low temperature for different times and the subsequent drying then completed at a higher temperature. Similarly, sheets were partially dried at a high temperature and drying completed at a lower temperature. Results are given in Table VII.

TABLE VII

Effect of Temperature in Early Stages of Drying on the Plasticity of Air-Dried Sheet Containing R.P.A. No. 2

Dry-Rubber-Content of Latex = 15 per cent. Total Drying Time 96 hours

Sample No.	R.P.A. No. 2 added to Latex per cent.	Time of Drying (hours) and Temperatures				Plasticity	
		First Stage		Second Stage			
		120°F	140°F	120°F	140°F	Mooney value	M 50 value
L 113/1	—	—	—	—	96	72.5	63
L 113/2	—*	—	—	—	96	72.5	63
L 113/3	0.58	24	—	—	72	70	29
L 113/4	„	48	—	—	48	68	30
L 113/5	„	72	—	—	24	66.5	28
L 113/6	„	96	—	—	—	65	26
L 113/7	„	—	24	72	—	57	18
L 113/8	„	—	48	48	—	60	20
L 113/9	„	—	72	24	—	60	20
L 113/10	„	—	96	—	—	61.5	21

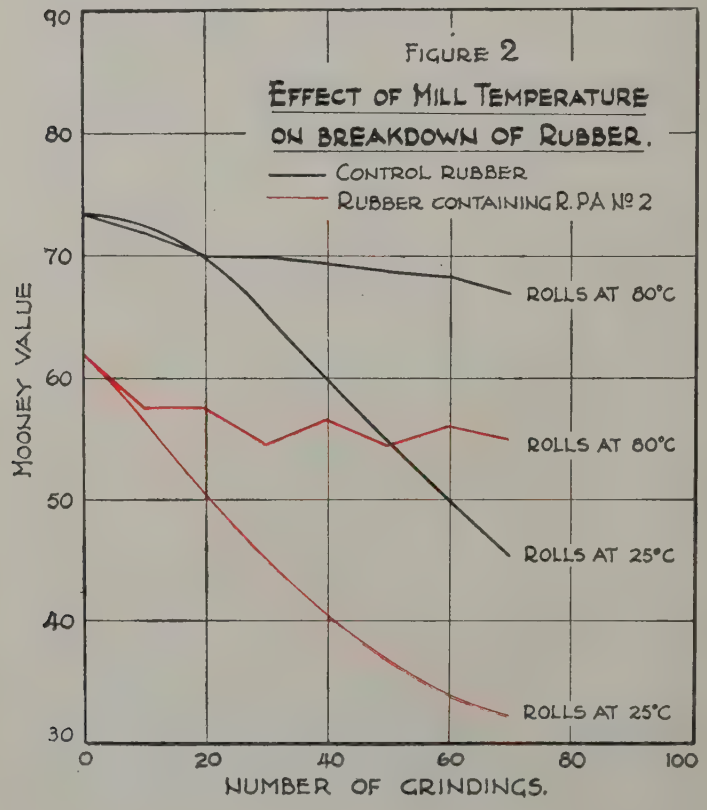
* Addition of emulsion of solvent without R.P.A. No. 2.

The M50 values indicate that it is in the early stages of the drying of the wet sheet that the effect of the drying temperatures is most pronounced. It appears therefore that high temperatures are only necessary during the early stages of drying. It was contrary to expectation that sample L 113/7, which had the

shortest period at 140°F. followed by completion of drying at 120°F., gave a softer rubber than L 113/10 which was completely dried at the higher temperature. Further tests however have confirmed these findings and it appears that maximum softening is usually obtained by maintaining the wet sheet at a high temperature during the early stages of drying and then completing the process at a lower temperature.

The Effect of Milling Temperature on Plasticity

In connection with the recommendation that R.P.A. No. 2 should be used for breaking down rubber on a mill at a high temperature, the figures given in Table VIII and Figure 2 are of interest. They represent the plasticity readings obtained after masticating sheet rubber prepared from latex to which R.P.A.



No. 2 emulsion had been added prior to coagulation, together with those obtained on the normal sheets controls. Milling was carried out with the rolls maintained at temperatures of 80°C. and 25°C.

TABLE VIII

Effect of Mill Temperature on Breakdown of Rubber Containing R.P.A. No. 2

No. of Grindings	Normal Raw Rubber		Rubber containing R.P.A. No. 2	
	Rolls at 25°C.	Rolls at 80°C.	Rolls at 25°C.	Rolls at 80°C.
—	73.5	73.5	61.5	61.5
10	72.5	72	56	57
20	70	70	50	57
30	65	70	44	54
40	60	69.5	40	56
50	55.5	69	36.5	54
60	50	68.5	—	55.5
70	45.5	67	32	54.5

These figures indicate that cold mill mastication is more effective in promoting the breakdown of both normal raw rubber and of rubber into which R.P.A. No. 2 has been incorporated during preparation. Although the latter rubber is initially much softer than the control and therefore would not require as much mastication to attain the same plasticity, any softening required appears more likely to be effectively produced at cold rather than hot mill temperatures. It would be of interest to ascertain if these observations could be substantiated on a production scale of milling.

The Effect of Washing the Coagulum

As it is necessary to use water sprays on the machines during the rolling of coagulum to sheet, and the amount of washing which is given during this process varies in estate practice, it was considered advisable to ascertain whether any possible losses of R.P.A. No. 2 would be sufficient to affect the plasticity. Coagula

prepared from latex containing equal amounts of R.P.A. No. 2 emulsion, were milled on a sheeting battery using (a) a small water supply and (b) a very full supply followed by soaking the sheet after machining for a period of two hours in running water. The sheets were then dried at 120° and 140°F. Table IX gives the plasticity results obtained after the storage of the samples for eleven months and indicates that no appreciable increase in softening is effected by varying the degree of washing.

TABLE IX

Effect on Plasticity of Washing during the Machining of Air-Dried Sheet Containing R.P.A. No. 2

Dry-Rubber-Content of Latex = 15 per cent.

Sample No.	R.P.A. No. 2 added on Rubber	Drying Temperature	Time of drying	Water Supply on Rolls	Soaking of Machined Sheet	Plasticity	
						Mooney value	M 50 value
	per cent.	°F	hours		hours		
L 65/1	—	120	146	Normal	—	86	74
L 65/2	0.66	„	115	Poor	—	73	26
L 65/3	0.66	„	115	„	2	71½	26
L 66/1	—	140	91	Normal	—	83	73
L 66/2	0.66	„	68	Full	—	61	15
L 66/3	0.66	„	68	„	2	65½	15

The Storage of Rubber Containing "Peptisers"

It is well known that the plasticity of raw rubber changes with age (7) (8), and it has been observed in this laboratory that sheet rubber invariably hardens on storage. It is therefore of importance to ascertain the behaviour on storage of rubber softened by the addition of "peptisers" during preparation, particularly as it is believed that the rate of hardening of raw rubber is more rapid in a temperate climate than in the tropics.

Determinations made on samples of rubber containing the "peptisers" incorporated during preparation and stored for various periods indicate that hardening does occur and in no single instance has a softening yet been observed. Table X

TABLE X

Effect on Plasticity of Storage of Rubber Containing "Peptiser"

Sample No.	Amount of Peptiser added per cent.		Plasticity shortly after Preparation		Plasticity after Storage		Increase in M 50 value per cent.
			Mooney value	M 50 value	Mooney value	M 50 value	
L 51	—	... ...	71	53	81	65	23
L 51/1	0.076	Thio-beta-Naphthol	74	33	80½	36	9
L 51/2	0.152	„	66	22	74	28	27
L 51/3	0.228	„	56	13	63	21	61
L 51/4	0.304	„	54	8	—	—	—
L 60	—	... ...	63.5	47	73	50	6
L 60/1	0.35	R.P.A. No. 2	64	22	71	27	23
L 60/2	0.52	„	59	14	64	18	29
L 60/3	0.69	„	53	7	58	14	100

contains the results of plasticity measurement on the L 51 and L 60 series of samples (Tables I and IV) tested after storage for sixteen and twelve months respectively, together with the original figures for comparison.

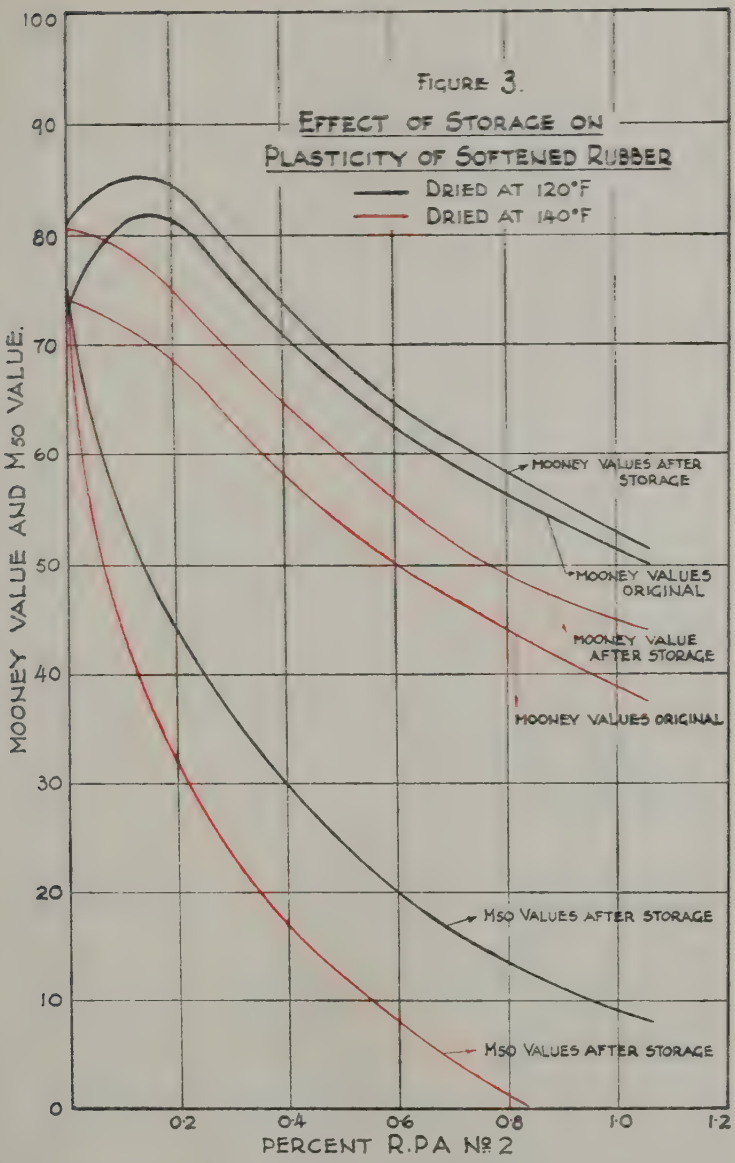
From the figures showing the increase in the amount of mastication required to give the M 50 value it appears that the hardening increases as the amount of "peptiser" in the rubber increases.

Table XI and Figure 3 show plasticity values obtained after storage for nine months of the L 70 and L 70/1/1 series of rubbers containing increasing amounts of R.P.A. No. 2 and dried at different temperatures (Table V).

TABLE XI

Effect on Plasticity of Storage of Air-Dried Sheet Containing R.P.A. No. 2

Sample No.	R.P.A. No. 2 added on Rubber per cent.	Drying Temperature °F	Plasticity shortly after Preparation Mooney value	Plasticity after Storage	
				Mooney value	M 50 value
L 70/1	—	120	73	81	75
L 70/2	0.18	„	82	85	46
L 70/3	0.36	„	73	76	35
L 70/4	0.53	„	65	67½	24
L 70/5	0.71	„	59	61	16
L 70/6	0.88	„	54½	57	12
L 70/7	1.06	„	50	51½	8
L 70/1/1	—	140	74	80½	75
L 70/2/1	0.18	„	69½	76	34
L 70/3/1	0.36	„	60	65	19
L 70/4/1	0.53	„	52½	56½	11
L 70/5/1	0.71	„	47	52	4
L 70/6/1	0.88	„	43	49	—
L 70/7/1	1.06	„	37½	44	—



Unfortunately mastication tests were not carried out when the rubbers were first prepared and therefore it is not possible to say if the hardening of sheet containing a given amount of R.P.A. No. 2 is affected by the temperature of drying. From

the position of the curves in Figure 2 giving the Mooney values before and after storage, it would appear that more hardening has occurred in the samples dried at 140°F. than in those dried at 120°F. From the general parallelism which these curves exhibit it appears that more rapid hardening on storage will occur in rubbers containing larger amounts of R.P.A. No. 2 and dried at the higher temperatures. From the curves showing the M 50 values after storage of the samples dried at 120° and 140°F. it is evident that the higher drying temperature becomes more effective as the amount of R.P.A. No. 2 increases. Sheet rubber containing 0.18 per cent of R.P.A. No. 2 and dried at 140°F. requires 26 per cent less mastication than that dried at 120°F., but when the amount of R.P.A. No. 2 is increased to 0.71 per cent this figure is raised to 87 per cent.

Soft Rubber from different Latices

It has been found* that rubber prepared in identical manner from latex of different sources varies in its plasticity. In order to ascertain if the addition of "peptiser" would eliminate these differences, equal amounts of R.P.A. No. 2 emulsions were added to latex obtained from clones P.B. 186 and Tj. 1. Clone P.B. 186 has been found to give consistently a rubber which is considerably softer than the average smoked sheet (9), whilst clone Tj. 1 yields rubber which is extremely hard. The results of the plasticity determinations made shortly after preparation and after ten months' storage are shown in Table XII. They indicate that differences in plasticity caused by inherent differences in latex still remain.

TABLE XII

Plasticity of Smoked Sheet from different Latices containing R.P.A. No. 2

Dry-Rubber-Content of Latex = 15 per cent. R.P.A. No. 2 added = 0.70 per cent. on Rubber

Sample No.	Latex of Clone	Initial Plasticity	Plasticity after Storage	
		Mooney value	Mooney value	M 50 value
L 64/1	P. B. 186	43	55	11
L 64/2	Tj. 1	72	81	37

* Unpublished work.

Experiments with R.P.A. No. 3

With the recent introduction of R.P.A. No. 3 to the rubber industry by Messrs Du Pont, the preparation of soft rubber from latex has been both simplified and cheapened. This "peptiser" is a liquid which is not miscible with water or latex and in order to incorporate it into the rubber during the preparation it must first be emulsified as in the case of R.P.A. No. 2, but as no solvent is required the cost of production of the emulsions is considerably cheaper than for R.P.A. No. 2. With the small sample of this "peptiser" available only a few preliminary experiments have been possible but it appears that its behaviour when added to latex prior to coagulation is similar to that of R.P.A. No. 2, but, contrary to information received (10), it does not appear to be quite as effective when used in equal amounts.

Preparation of Soft Rubber on a Large Scale

The experiments described show the possibility of the preparation of a soft rubber on the plantations. The preparation of the necessary emulsions however would not be as easily carried out on an estate as in the laboratory; moreover, power to run the homogeniser used for emulsification is not always available. It appeared desirable therefore to investigate the possibilities of making emulsions in a manner which could be readily carried out in estate practice without the use of a homogeniser or other expensive plant.

By the courtesy of Imperial Chemical Industries (Malaya) Ltd., a number of different stabilisers and emulsifying agents were obtained, but it was not found possible to prepare satisfactory emulsions unless the R.P.A. No. 2 was first dispersed in a solvent. Kerosene was successfully used for this purpose instead of benzene and the cost of the emulsion was thereby slightly reduced. By using the "Two solution" method, which is well known in agricultural practice for the preparation of horticultural washes, it was found that reasonably stable emulsions suitable for the purpose could be made without the use of a homogeniser. The method requires an emulsifying agent which is soluble in the oil to be emulsified and a true oil-in-water emulsion forms when the solution is added with stirring to water containing a little alkali. The emulsifying agent used for these experiments was Agral W.B.S. The emulsions were best prepared shortly before they were required for use, by dissolving the R.P.A. No. 2 and Agral W.B.S. in kerosene and then adding this mixture, with thorough stirring, to an equal volume of water containing a very

small amount of caustic soda. A suitable emulsion is made by using the following proportions:—

10 grammes R.P.A. No. 2 dissolved in 100 c.c. of kerosene

1 gramme Agral W.B.S.

100 c.c. of water containing 0.5 grammes caustic soda.

Several large-scale batches of smoked sheet have been successfully made using R.P.A. No. 2 as an emulsion prepared in this way, and although there is a tendency for the emulsion to separate rather quickly on standing it is unnecessary to prepare it until required for use.

Table XIII shows the plasticity figures determined on four separate batches prepared in a manner which could be readily duplicated in all respects on the plantations. After diluting the latex to 1½ lb. D.R.C. per gallon the emulsion prepared as described above was mixed with the latex in the coagulating tank, followed by the addition of the coagulant. It was observed that the froth which is inevitable during the mixing of the latex with the emulsion subsequently coagulated on the addition of the acid and some of the dry sheet had an appearance similar to that of sheet prepared from latex in which precoagulation had occurred. This was avoided by homogenising the emulsion before adding it to the latex, although it seems to be unnecessary because the peptiser is uniformly distributed, and the appearance of the sheet is of secondary importance when a special type of rubber is to be prepared.

TABLE XIII

Tank Preparation of Softened Smoked Sheet Rubber

Volume of Emulsion added = 2.2 per cent. of Volume of Latex

Sample No.	R.P.A. No. 2 added on Rubber per cent.	Plasticity	
		Mooney value	M 50 value
L 110	0.75	62	21
L 109	0.72	58	15
L 108	0.72	60	20
L 107	0.72	62	22

The emulsification of R.P.A. No. 3 is also much simplified by the use of the "two solution" method, and laboratory preparations have remained stable for a considerable time. It is anticipated that they will prove equally successful on a large scale.

Discussion

The results of the experiments carried out on the preparation of soft sheet rubber, by the incorporation of "peptising agents" into latex prior to coagulation, indicate that an important factor influencing the softness of the dry sheet is the temperature at which drying takes place. If the preparation of soft rubber were undertaken on the plantations it would be necessary for the strictest control of the temperature to be maintained in the smoke-house during the drying. Estates equipped with the more modern types of drying houses which have been described from time to time would therefore be better able to do this efficiently. The experiments have also indicated that emulsions of the "peptisers" could be prepared on the plantations and introduced into the latex to give uniform distribution of the "peptiser" in the rubber without much difficulty. Although it now appears that the purchase of a homogeniser would be unnecessary it would be desirable to use a mechanical stirrer to assist in the emulsification, but suitable provision for this should not be difficult in the average estate factory where engines are available for running the machinery. In view of the recommendations made by the producers of the "peptising agents" concerning the health hazards incurred in their use, it would be necessary in estate practice to ensure that the greatest care was taken in the handling of both "peptiser" and its emulsion. Estate labour would need to be informed of the possible dangers and instructed in the precautions to be taken to avoid contact with the skin. Those who have come in contact with the chemical should thoroughly wash themselves as soon as possible after contact.

In the preceding communication Wentworth, discussing the softening of rubber, indicates that there appears to be a real demand for a rubber softer than that now supplied by the plantations. From the results of the experiments reported above it is considered that this demand could be met by the producers. It is necessary, however, first to ascertain whether the degree of softening which can be induced by the methods proposed is sufficient to interest the consumer, and then to consider whether the process can be operated at an economic cost.

Samples of softened smoked sheet prepared in the manner described have been sent to London, and the opinion has

been expressed that there may be a market for it because it is so much easier to break down. Whether it is of sufficient value to warrant the payment by the consumer of a premium which would cover production costs and give the producer some return for the extra work involved in its preparation it is not yet possible to say. Estimates of the expenses involved in the preparation indicate that it is likely that it could be made and sold for a premium lower than that which is reported to be paid for rubber softened by a patented process.

As a result of the work and because the methods involved in the preparation are simple, it is felt that the economic and practical considerations involved in the use of the process might well be investigated further. It is hoped that a market will be found for this modified rubber.

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